United States
Environmental Protection
Agency

Economic and Benefits Analysis for Policy Scenarios Associated with Long-Term Stormwater Management for Developed Areas

Volume 2: Project Cost Model (PCM)

November 20, 2014

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1 Introduction

1.1 Project Cost Model (PCM) Background

The Economic Analsyis associated with Long-Term Stormwater Management policy scenarios begins by combining forecasts of population growth and construction value with distributions of observed project characteristics. These data are used to estimate a *baseline forecast of new and redevelopment projects* covering the period 2016 – 2050. This projection is forcast using the Project Prediction Model (PPM)[1] developed by Abt Associates for this analysis. The methodology for predicting projects and assigning attributes is documented in Volume I of the EA (Volume I: Project Prediction Model). In addition to projecting new and redevelopment projects over this time period, an estimate of road construction and repair is also forecast. The methodology for predicting future transportation development is documented in the memorandum *Estimating Transportation Development and Associated Compliance Costs,* presented as Appendix A.

After all projects and transportation development has been forecast, the cost of meeting each simulated policy standard is calculated using a series of algorithms that combine data from the PPM with data from the Engineering Analysis, documented in the *Least Cost Mix of BMPs Analysis- Final Report*.[2] This set of algorithms estimates the cost of stormwater BMPs that may occur on the national landscape. These calculations are performed for every project under 1) the project's existing (i.e. baseline) regulatory requirements and 2) each [redacted] simulated policy scenarios. [redacted]

Initial unit costs and runoff characteristics are derived from the engineering model site analysis. The engineering analysis produces unit costs and runoff estimates for a series of 34 model sites, referred to as Standard Land Development Models (SLDMs). Costs for each SLDM vary according to site-specific factors such as soil and climate, and also vary according to assumptions used with respect to regulatory constraints, including restrictions on the use of control practices. Unit cost concepts include BMP capital, operation and maintenance (O&M), and replacement costs. Engineering results are contained in a series of output tables, with each combination of SLDM, site conditions, and site constraints combined to create a unique identifier referred to as a SAUID.

Output from the Engineering Analysis represents a range of circumstances facing developers when they are considering how to manage stormwater for a future project. Accordingly, costs associated with each of these circumstances are modeled. All projects generated by the PPM are assigned a suite of characteristics, each of which is relevant to estimating compliance costs:

- State/MSA,
- HUC 12 watershed identifier,
- Construction type,
- Development type (e.g., new development or redevelopment),
- Regulated Municipal Separate Storm Sewer System (MS4) status,
- Soil type,

[1] See technical documentation, *Economic and Benefits Analysis for Policy Scenarios Associated with Long-Term Stormwater Management for Developed Areas, Volume 1: Project Prediction Model*, Final Date Here. U.S. EPA, Office of Water, Office of Science and Technology, Engineering and Analysis Division.

[2] Abt Associates will obtain the formal reference for this report from the EPA WAM

- Project area (acres),
- Impervious surface percentage,
- Climate station identifier,
- Combined Sewer System (CSS) status, and
- Year construction completed.

The first portion of the cost analysis categorizes projects into groups that can be matched to Engineering Analysis output tables. For each MSA and non-MSA-State location (406 locations in the coterminous USA), projects are grouped by location, and all projects occurring in areas served by a CSS are removed from further consideration.

Next, projects are partitioned into groups based upon construction type, development type, and whether the location is within an MSA or non-MSA area. Using these characteristics, projects are assigned appropriate land values. The methodology for deriving land values, and estimated uncertainty in these derived values, is documented in memorandum *Stormwater Rule Land Values Methodology and Results,* presented as Appendix B.

[redacted]. The calculations conducted that convert PPM and Engineering data to national costs are performed using the Project Cost Model (PCM) developed for economic analyses of policy scenarios.

1.2 Overview of Key Analysis Components Affecting Developer Behavior

The primary purpose of the project cost model is to characterize differences between the circumstances developers would experience under existing state and local regulation (e.g., the baseline) and what they would experience under each policy scenario modeled. Principle among these differences is the incremental difference in stormwater management control costs (e.g., capital, O&M, and replacement costs). However, a suite of other factors can affect the way developers respond to the rule. These factors include the opportunity cost of land, potential cost savings through improved construction techniques, and the extent to which individual policy scenarios may alter existing state and local requirements for development projects. Land resources devoted to managing stormwater may be precluded from being used for other productive purposes and is therefore a potential opportunity cost to developers. Conversely, changes to site design made to facilitate compliance with the rule may “free-up” land or other resources (e.g., reduced spending for impervious materials), creating cost savings for developers.

1.2.1 Opportunity Costs

To comply with rule [redacted], developers may alter a project’s use of land. [redacted]

Existing state and local development requirements create similar compliance costs for developers that can often lead to opportunity costs of a similar character. [redacted]

[redacted]

1.2.2 Changes to Existing Regulatory Constraints

[redacted]

In areas that are currently subject to stormwater *treatment* standards, conventional management practices include primarily wet or dry detention ponds, underground treatment vaults, or sand filters.[3] [redacted]

Many localities have old codes and ordinances that pose unnecessary restrictions on site design. These regulations may prevent developers from reducing the amount of IS used for site features, such as streets and parking lots. [redacted]

[redacted]

1.2.3 Environmental Site Design

[redacted]

3 [redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]

[redacted]

1.3 Organization of this Document

In this document, we provide a walk-through of the PCM, [redacted]

The PCM can be functionally separated into five discrete sections:

1. A series of algorimths that calculates the potential for Environmental Site Design (ESD) to occur on projects, at a national scale, on a per-project basis (Section 0).
2. A set of database queries that collects raw data from various Engineering Databases, including cost tables, water quality tables, and tables generated to estimate flood storage costs (Section 4).
3. A series of algorithms that take raw engineering costs and applies various economic assumptions and calculations to estimate detailed project costs on a per-project scale, for all projects nationally (Section 5).

4. A series of comparisons between baseline and rule options [redacted] (Section 6).
5. An aggregation algorithm which applies various assumptions to various geographical and/or scenario assumptions to estimate the national cost of the stormwater rule (Section 7).

[redacted]

2 Cost Modeling Case Definitions & Assumptions

The PPM documentation[4] describes in detail how project attributes, such as location, size, and regulatory status are assigned to each project. [redacted]

Table 2-1: Nine cases and associated economic assumptions considered by the PCM

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

4 *Economic and Benefits Analysis for Policy Scenarios Associated with Long-Term Stormwater Management Rule for Developed Areas, Volume 1: Project Prediction Model*, June 20, 2014. Prepared for Todd Doley, U.S. EPA, Office of Water, Office of Science and Technology, Engineering and Analysis Division, under EPA contract EP-C-07-023

Table 2-2: Primary cost scenarios, and their constituent cases, assessed by the PCM		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

Table 2-3: Fraction of projects assigned to cases under baseline and policy scenarios
[redacted]

[redacted]

[redacted]

[redacted]

Table 2-4: Retention Standards

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			

[redacted]

[redacted]

Table 2-5: Sample projects, and relevant project characteristics determined by the PPM. (Excel Tab: Preliminary Inputs)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

3 Calculating Environmental Site Design

[redacted]

[redacted]

A general overview of this process is found in Figure 3-1, and discussed below.

[redacted]

Figure 3-1: Overview of the ESD Calculation Algorithm

3.1 Setup and Data Collection

[redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]

Table 3-1: Land values, engineering databases and cost flags for all scenarios assigned to sample projects. (Excel Tab: Land Value, DBs, Standards)

[redacted]

3.2 ESD Calculation

[redacted]

[redacted]

3.2.1 Maximum Reductions in IS

[redacted]

[redacted]

[redacted]

Table 3-2: Maximum ESD reductions and construction cost savings per acre of IS for combinations of construction type and construction density (Excel Tab: Max ESD Reduction)

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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3.2.2 Nonstructural Control Impermissible: Cases A - C

[redacted]

3.2.3 ESD With No Nonstructural Control Opportunity Costs (NSCOC): Cases D - F

[redacted]

[redacted]

Table 3-3: Land values, databases and cost flags are assigned. (Excel Tab: Land Value, DBs, Standards)

[redacted]	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]	[redacted]			[redacted]		[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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3.2.4 ESD with Nonstructural Control Opportunity Costs (NSCOC): Cases G - I

[redacted]

[redacted]

Capital Costs

[redacted]

Table 3-4: Maximum ESD reductions and construction cost savings per acre of IS for combinations of construction type and construction density (Excel Tab: ESD Oppcost 4_high_h)

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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Figure 3-2: Capital costs as a function of IS% [redacted]

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Construction Cost Savings

[redacted]

Nonstructrual Control Opportunity Costs

[redacted]

Calculating Final Project IS

[redacted]

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Table 3-5: Construction Cost Savings, Changes in NSCOC and Capital Costs Calculated for 100 Iterations of IS % to determine change in IS%. (Excel Tab: ESD Oppcost 4_high_h)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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3.2.5 Reassigning Standard Area Unit IDentifiers (SAUIDs)

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[redacted]

Table 3-6: SLDM Imperviousness Fractions by Construction Type (Excel Tab: SLDMs)

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Table 3-7: SLDMs, SLDM Area, and SAUIDs for Four Sample Projects (Excel Tab: Final SAUIDs)

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4 Engineering Database Queries

[redacted]

A general overview of this process is found in Figure 4-1, and discussed below.

[redacted]

Figure 4-1: Overview of Database Queries

[redacted]

4.1 Cost Database Query

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Table 4-1: Cost Information for all SAUIDs Associate with the Four Sample Projects (Excel Tab: Cost Data Query)

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Table 4-1: Cost Information for all SAUIDs Associate with the Four Sample Projects (Excel Tab: Cost Data Query)

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4.2 Water Quality Database Query

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[redacted]

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Table 4-2: Cost Information for all SAUIDs Associate with the Four Sample Projects (Excel Tab: WQ Data Query)

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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 4-2: Cost Information for all SAUIDs Associate with the Four Sample Projects (Excel Tab: WQ Data Query)

[redacted]	[redacted]						
[redacted]	[redacted]						
[redacted]	[redacted]						
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

4.3 Flood Storage Cost Query

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Table 4-3: Flood Storage Size and Costs for all Sample Project (Excel Tab: Pond[5] Data Query)

[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

5 [redacted]

5 Cost Calculations

[redacted]

A general overview of this process is found in Figure 5-1, and discussed below.

[redacted]

Figure 5-1 Overview of Cost Calculations Performed on Raw Data Queried from Databases

5.1 Cost Calculations

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

A summary of all annualized costs and calculations is presented in Table 5-2..

Table 5-1: Summary O&M costs (Annual and Maintenance) for all SAUIDs Associate with the Four Sample Projects (Excel Tab: O&M Stream-final; raw data at level of individual BMPs in Excel Tab: O&M Stream – separated)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]																				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]																				

Table 5-2: Summary of annualized costs for all SAUIDs Associate with the Four Sample Projects (Excel Tab: Annualized SAUID Costs)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

5.2 Combining SAUID Costs to Project Costs

[redacted]

[redacted]

Table 5-3: Summary of costs for all SAUIDs Associate with the Four Sample Projects (Excel Tab: Annualized SAUID Costs)

[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

5.3 Calculating Project-Level Flood Storage Costs

[redacted]

Table 5-4: Fraction of projects assigned to cases under baseline and rule scenarios

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

[redacted]

Table 5-5: Flood storage costs and pond areas assigned to projects under the high retention standard.				
[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

5.4 Case-Specific Costs Written to Cost Database

[redacted]

Table 5-6: Cost Calculations Written to the Cost Database (Excel Tab: Scen, Case as Written to DB)				
[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 5-6: Cost Calculations Written to the Cost Database (Excel Tab: Scen, Case as Written to DB)

[redacted]	[redacted]			
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

6 Stringency Analysis

Many states and regulated MS4s currently have existing standards to address stormwater. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Figure 6-1: Overview of the Stringency Analysis Conducted to Ensure Water Quality Protection

6.1 SAUID-Level Stringency Analysis

[redacted]

[redacted]

[redacted]

Table 6-1: Raw Preliminary Stringency Analysis Data (Excel Tab: Stringency Matrix)

[redacted]			[redacted]	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]

[redacted]

Table 6-2: Summary of Preliminary Stringency Analysis (Excel Tab: Stringency Summary)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

6.2 Project-Based Stringency Analysis

[redacted]

- [redacted]
- [redacted]
- [redacted]

7 Project Cost Aggregation

[redacted]

[redacted]

[redacted].

[redacted]

Figure 7-1: Overview of the Cost Aggregation Algorithm Within the Project Cost Model

7.1 Assigning Cases to Projects

[redacted]

Table 7-1: Summary of Preliminary Stringency Analysis (Excel Tab: Case Assignment)

		[redacted]	[redacted]		[redacted]		[redacted]		[redacted]	
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted].

7.2 Assigning Learning Costs to Projects

[redacted]

7.3 Calculating Flood Storage Opporunity Costs

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.4 Correcting for Federal Projects

[redacted] According to the Census' 2010 census of construction spending, Federal construction accounted for 3.9% of total construction spending in the commercial/institutional category between 2002 – 2010. [redacted]

[redacted]

[redacted]

7.5 Calculating Incremental Project Costs

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.6 Modifing Projects in States with Protective Rules

In some states, existing regulations require stormwater retention and are defined by precipitation depth (e.g., the same metric used by policy scenarios). [redacted]

[redacted]

[redacted]

Table 7-2: State-Level Stringency Analysis (Excel Tab: Existing Better)

[redacted]

[redacted]

7.7 Zeroing-out Negative Flood Storage Costs

[redacted]

7.8 Calculating Project-Level Total Costs

[redacted]

[redacted]

[redacted]

[redacted]

Table 7-3: Project-Level Incremental Costs Prior to Aggregation (Excel Tab: Scenario 4 Low Marginal Corr)

[redacted]		[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 7-3: Project-Level Incremental Costs Prior to Aggregation (Excel Tab: Scenario 4 Low Marginal Corr)

[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

7.9 Cost Aggregation

[redacted]

8 National Cost Results

8.1 Cost Attributes

As described in documentation for the Project Prediction model,[6] projects are assigned several attributes that affect the cost of stormwater control. [redacted]

Table 8-1: Attributes assigned to each project by the project prediction model

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

8.2 National Costs

[redacted]

[redacted]

[6] See technical documentation, *Economic and Benefits Analysis for Policy Scenarios Associated with Long-Term Stormwater Management for Developed Areas, Volume 1: Project Prediction Model*, Final Date Here. U.S. EPA, Office of Water, Office of Science and Technology, Engineering and Analysis Division.

Table 8-2: Overview of annualized national cost estimates [redacted]

[redacted]

Figure 8-1: Annualized national cost components [redacted]

Table 8-3: Summary of annualized national cost components [redacted]

[redacted]	[redacted]	[redacted]			[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]							

[redacted]

[redacted]

Table 8-4: Overview of annualized national cost estimates [redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]
	[redacted]	[redacted]

9 Uncertainties and Limitations

Estimating the costs associated with stormwater management at a national scale, for projects predicted with realtively fine-scale geographic granularity (HUC-12) is a complex process that requires many assumptions, and use of multiple external databases and models as inputs. In turn, each of these data sets, though often treated as certain point estimates by the PCM, are inherently uncertain.

There are three major categories of uncertainty within the national PCM, each of which will be explored further:

- *Uncertainty driven by future events*
- *Uncertainties associated with model inputs*
- *Model assumptions*

Within each of these source categories, estimates of uncertainty can be characterized in several ways:

- *Quantifiable and formally quantified.* For sources of uncertainty where quantitative estimates have been generated, formal uncertainty analyses can be conducted when sufficient resources are available. [redacted]
- *Quantifiable and informally quantified.* In many cases, quantifying the magnitude of uncertainty in a rigorous fashion is time and resource intensive. [redacted]
- *Quantifiable but not quantified*. In many cases, uncertainty is quantifiable (for example, by providing estimates of uncertainty around mean values) but estimates of this uncertainty are unavailable, or have not been provided by input databases. [redacted]
- *Non-quantifiable*. In many cases, uncertainty cannot be quantified. In these cases, although the source of uncertainty can be identified, the potential magnitude of the impacts is not knowable. [redacted]

[redacted]

9.1 Uncertainty Associated With Future Events

[redacted]

9.2 Uncertainty Associated With Model Inputs

The PCM uses external datasets to estimate the cost of national stormwater control. These data sets include:

- [redacted]

Table 9-1: Average forecast development and estimates of uncertainty for aggregate national development by development and construction type, 2016 – 2040

[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

7 See *Economic and Benefits Analysis for Policy Scenarios Associated with Long-Term Stormwater Management Rule for Developed Areas, Volume 1: Project Prediction Model* for details of the uncertainty analysis.

8 *Least Cost Mix of BMPs Analysis- Final Report*

9 *Estimating the Reduction in Stormwater Detention Costs Associated with the Proposed On-Site Retention Standards for Stormwater Discharges from New Development and Redevelopment Sites.*

[redacted]

[redacted]

9.3 Uncertainty Associated With Model Assumptions

[redacted]

[redacted]

- [redacted]
- [redacted]
- ➢ [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
- [redacted]
- [redacted]

[redacted]

Table 9-2: Overview of annualized national cost estimates [redacted]

[redacted]	[redacted]	[redacted]			[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

Table 9-3: Summary of annualized national cost [redacted]

[redacted]	[redacted]	[redacted]			[redacted]			[redacted]			[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]			[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

Figure 9-1: Variability in annualized cost components and total stormwater compliance cost by scenario.

9.4 Overall Forecast Uncertainty

[redacted]

Table 9-4: Overview of annualized national cost estimates [redacted]

[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]

	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

Appendix A: Analysis of Transportation Costs

memorandum

Environment and Resources Division

Date 12/16/2013

To Todd Doley, US EPA/OW

From Dan Basoli and Jim Palardy

Subject Estimating Transportation Development and Associated Compliance Costs

1 Introduction

This memorandum describes the steps taken to estimate the quantity of lane-miles associated with future transportation development from 2018 – 2040, and the incremental cost of compliance for this development due to the proposed stormwater rule. The analysis focuses on estimating lane-miles for Tier 1 and Tier 2 roadways, as defined in Table A-1. [redacted]

Key steps in the analysis include:

- *Section 2* – Establishing a statistical relationship between roadway development and population, by Tier (supplied to Abt Associated by EPA)
- *Section 3* – Estimating county-level population by over time from 2018 – 2040, where each county's population is differentiated by the number of people in regulated MS4 areas as well as unregulated (non-MS4) areas. [redacted]
- *Section 4* – Estimating the quantity of future lane-miles developed in each county, by Tier and regulatory status (MS4, unregulated). These data are subsequently aggregated to the state-level for each time period to obtain state-level estimates of future lane-miles developed for the following combinations:
  - Tier 1, MS4
  - Tier 1, Non-MS4
  - Tier 2, MS4
  - Tier 2, Non-MS4
- [redacted]

2 Obtain Specified Relationships between County Population and Road Miles

A statistical relationship between lane-mile development and local population was developed by EPA using Census and Federal Highway Administration data sources:

- Federal Highway Administration data included "Total Lane-Mileage by Year, State, County, and Functional System (2000-2009 part)", and
- Census data included "County population, population change and estimated components of population change: April 1, 2000 to July 1, 2009."

[redacted] Roadways included in each tier are defined in Table A-1.

Table A-1: Roadway Tier Definitions

Road Tier	Description
1	Rural Interstate
1	Rural Other Principal Arterial
1	Urban Interstate
1	Urban Other Freeways & Expressways
1	Urban Other Principal Arterial
2	Rural Major Collector
2	Rural Minor Collector
2	Urban Collector
2	Rural Minor Arterial
2	Urban Minor Arterial
3	Rural Local
3	Urban Local

[redacted] The results from the tier-specific regressions are presented Table A-2 and Table A-3.[10]

Table A-2: Statistical Relationship between Tier 1 County Lane-Miles and County Population

[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

10 These relationships were obtained by Abt Associates from EPA in a June 16, 2011 memorandum entitled, "Initial Roads Analysis.doc".

Table A-3: Statistical Relationship between Tier 2 County Lane-Miles and County Population

[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Once total future county-level population estimates are obtained – from Section 3 – these relationships are used to estimate the total quantity of future county-level lane-miles.

3 Estimate Total County-Level Population Over Time

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
- [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]

[11] Obtained by Abt Associates from INDUS in April 2013 ("Block Expansion 2010.gdb")

[redacted]

[redacted]

4 Estimate Changes in Tier 1 and Tier 2 Lane-miles

[redacted]

- [redacted]
  - [redacted]
  - [redacted]
  - [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

Figure A-1 presents the number of lane-miles estimated to be developed during each time period, by roadway tier.

Figure A-1: Estimates of Lane-Miles Developed, by Tier

[redacted]

[redacted]

[redacted]

Figure A-2: MS4 Baseline, Estimates of Lane-Miles Developed, by MS4 Status

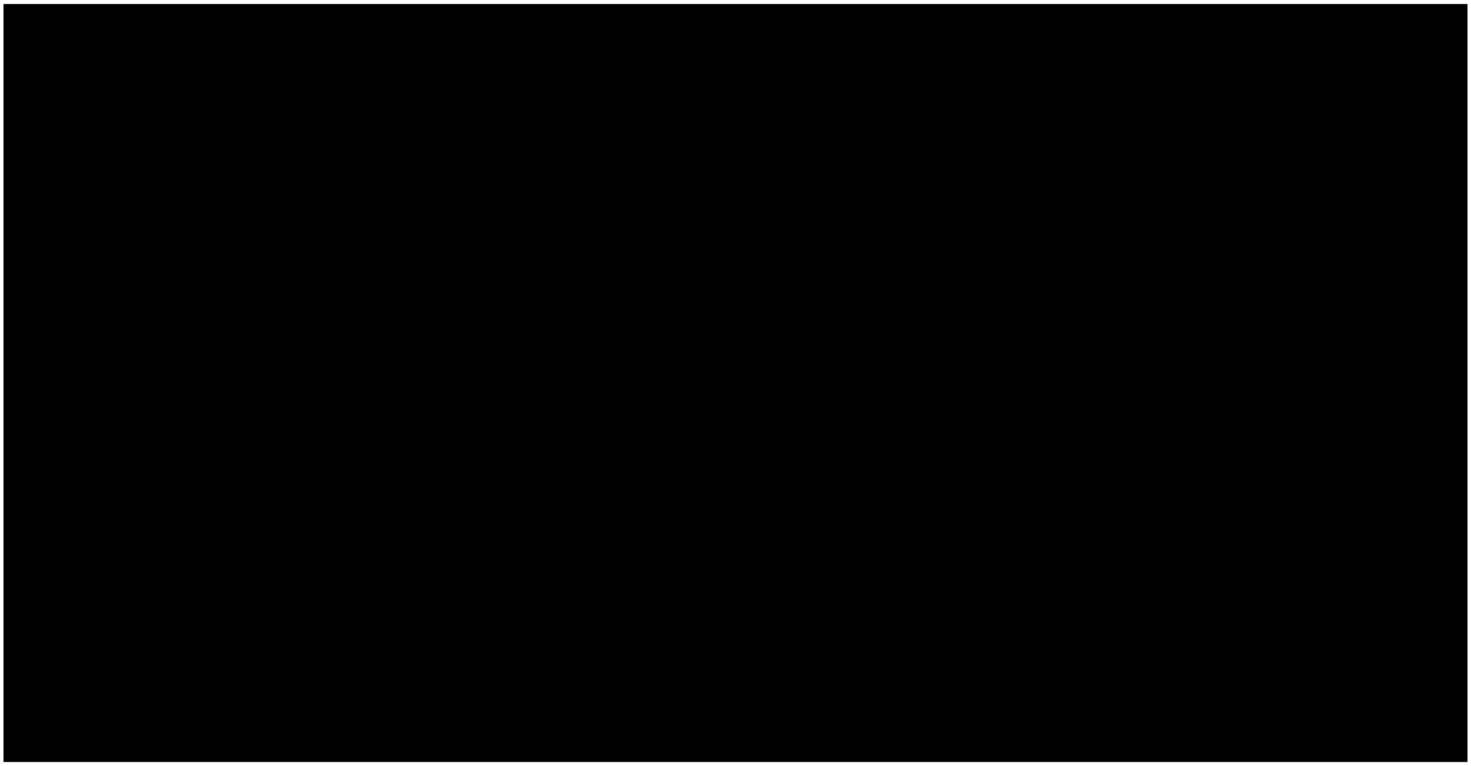

Figure A-3: MS4 HUC-12 Expansion, Estimates of Lane-Miles Developed, by MS4 Status

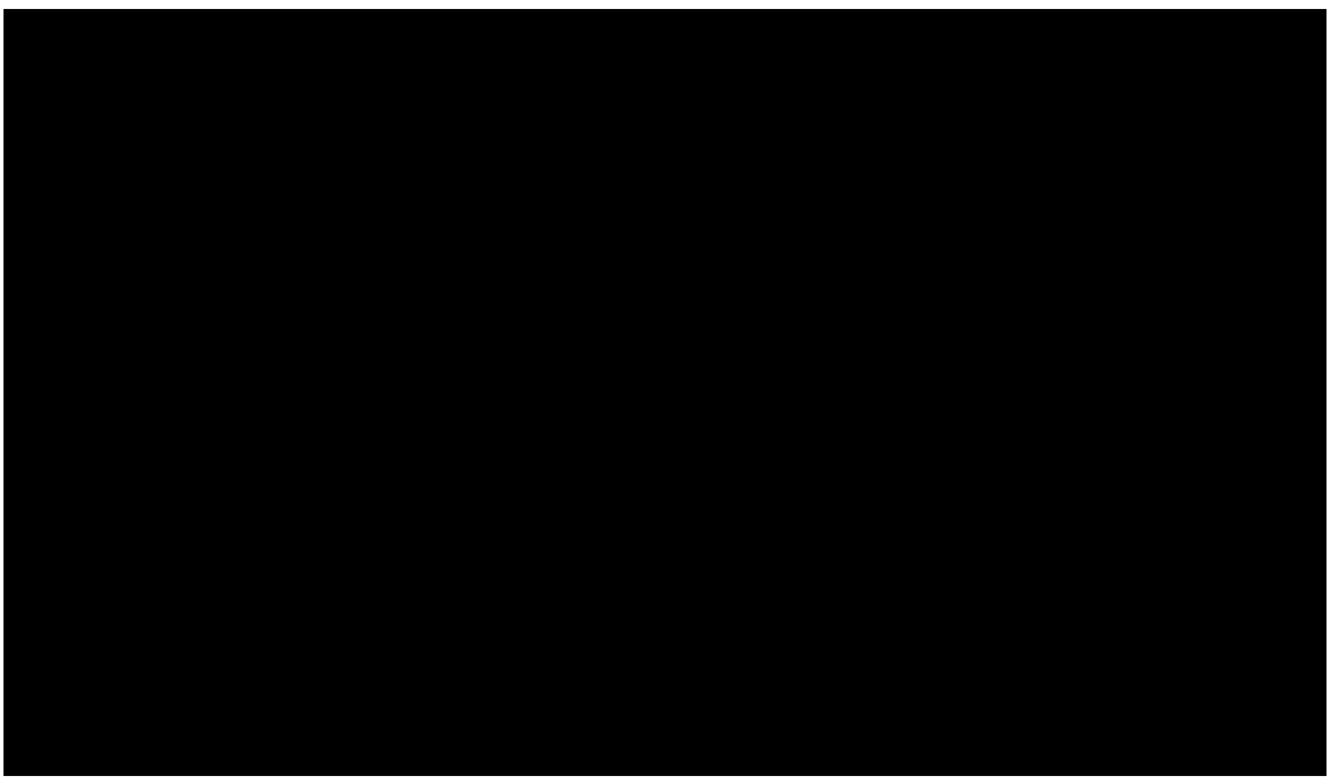

Figure A-4: MS4 HUC-10 Expansion, Estimates of Lane-Miles Developed, by MS4 Status

[redacted]

[redacted]

Table A-4: Proportion of Lane-Miles Developed in MS4 Areas, by time period

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

5 Estimate the Incremental Costs of Road Development

[redacted]

- [redacted]
- [redacted]
    - [redacted]
    - [redacted]

[redacted]

- [redacted]

[redacted]

    - [redacted]
  - [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
- [redacted]
  - [redacted]
  - [redacted]
- [redacted]
  - [redacted]
  - [redacted]

Appendix B: Estimating Residential and Non-Residential Land Values

memorandum

Environment and Resources Division

Date June 3, 2013

To Todd Doley, US EPA/OW

From Matthew Ranson, Ann Speers, Dan Basoli, Lauren Parker, and Paul Laskorski

Subject Residential, Commercial, and Industrial Land Value Results

1 Introduction

This memo describes the land values we have developed for use in the model facility analysis for the post-construction stormwater regulation. Our analysis draws on a general methodology developed by researchers at the Lincoln Institute for Land Policy (LILP) (Davis and Heathcote, 2007; Davis and Palumbo, 2007). Their methodology calculates the value of land as the difference between the sales price of a property and the construction cost of the buildings located on it. However, because the LILP has produced average land value estimates only for broad geographic units such as states and MSAs, we have made several adjustments to their methodology in order to generate the more detailed data necessary for analysis of the post-construction stormwater regulation. [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

The remainder of this memo provides more detail on our approach to estimating residential, commercial, and industrial property values.

2 Residential Land Values

2.1 Methodology

This section describes how we have calculated residential land values in the MSA and non-MSA areas surrounding each rain gauge.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[13] See: http://www.lincolninst.edu/subcenters/land-values/land-prices-by-state.asp and http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp.

[redacted]

[redacted]

[redacted]

[redacted]

2.2 Results

[redacted]

[14] http://www.inman.com/news/2011/12/6/room-roam-top-10-us-states-with-largest-lot-sizes?page=0%2C10

[15] http://www.census.gov/construction/chars/sold.html. See: “Lot Size Range”, soldlotsize_cust xls [MALotSizeSold].

[redacted]

Figure B-1: Residential Land Values, by Rain Gauge and MSA/non-MSA Status

[redacted]

3 Commercial and Industrial Land Values

[redacted]
The following subsections describe these steps in greater detail.

3.1 Land Value Ratios

3.1.1 Data

[redacted]

[redacted]

Table B-1. Summary Statistics by Land Use Type

[redacted]

3.1.2 Hedonic Analysis

[redacted]

- [redacted]
- [redacted]
- [redacted]

[16] Freeman, M.F. (2003). The Measurement of Environmental and Resource Attributes (2nd Edition). Washington, D.C.: RFF Press.

[redacted]

Table B-2. Fixed-effects Hedonic Regression Results

[redacted]

[redacted]

3.1.3 Land Value Ratio Results

[redacted]

[redacted]

[redacted]

Table B-3. Land Value Ratios From Hedonic Regressions [redacted]

[redacted]

3.2 Results

[redacted]

4 Limitations and Uncertainties

There are limitations and uncertainties associated with our estimates of the value of land. For example:

- [redacted]

5 References

Davis, Morris, and Jonathan Heathcote. 2007. "The Price and Quantity of Residential Land in the United States." Journal of Monetary Economics 54(8): 2595-2620. Data located at "Land Prices by State," Lincoln Institute of Land Policy, http://www.lincolninst.edu/subcenters/land-values/land-prices-by-state.asp. See also http://www.federalreserve.gov/pubs/feds/2004/200437/200437pap.pdf.

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[19] See U.S. Census Bureau. 2012. "Lot Size of New Single-Family Houses Sold." http://www.census.gov/construction/chars/sold.html

[20] As documented in Abt Associates' 10/23/2012 memorandum, "Adjusting LILP Data to Reflect the Value of Raw Land," this adjustment factor reflects the fraction of "improved" lot value that can be attributed to the raw land. The above-described process of imputing land values from property values by subtracting out construction costs provides, implicitly, a value for land that is understood to have some level of "improvement" (e.g., clearing, grading). We therefore use these direct estimates for the "redeveloped" land values, and the adjusted land values (i.e., backing-out the proportion of value associated with those improvements) for "new" land values.

Davis, Morris, and Michael G. Palumbo. 2007. "The Price of Residential Land in Large US Cities,." Journal of Urban Economics 63(1): 352-384. Data located at "Land Prices for 46 Metro Areas," Lincoln Institute of Land Policy, http://www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp.

Glaeser, Edward, and Joseph Gyourko. 2005. "Urban Decline and Durable Housing." Journal of Political Economy 113(2): 345-375.

Kiel, Katherine, and Jeffrey Zabel. 2003. "The Accuracy of Owner-Provided House Values: The 1978-1991 American Housing Survey." Real Estate Economics 27(2): 263-298.